SB 22-138

Legislative Council Staff

Nonpartisan Services for Colorado's Legislature

Greenhouse Gas Emissions Report

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BILL TOPIC:	**REDUCE GREENHOUSE GAS EMISSIONS IN COLORADO**		
Sectors Impacted:	☒ Electric Power ☒ Transportation ☐ Industrial Processes ☐ Waste Management ☐ Agriculture		☐ Natural Gas and Oil Systems ☐ Residential / Commercial / Industrial Fuel Use ☐ Coal Mining and Abandoned Mines ☐ Land Use / Land Use Change / Forestry ☐ Other
Net Change:	☐ Increase	☒ Decrease	☐ Indeterminate ☐ Minimal
Report Status:	This report reflects the introduced bill.		

Emissions Summary

This greenhouse gas (GHG) emissions report[1] analyzes the potential impacts of Senate Bill 22-138 on greenhouse gas emissions and sequestration within a 10-year period following enactment, based on available data. This analysis is focused on selected provisions contained in the bill, and does not address other provisions that are not expected to directly impact GHG emissions.

SB 22-138 will reduce GHG emissions by providing incentives through an income tax credit and a commercial rebate program to convert gas-powered lawn and garden equipment with electric-powered equipment between calendar years 2023 and 2029, and by prohibiting the sale of gas-powered lawn and garden equipment in nonattainment areas beginning in 2030.[2] GHG emissions savings will depend on a number of factors, including the number and type of gas-powered lawn and garden equipment converted to electric-powered equipment, the activity levels of residential and commercial users, and the emissions intensity of the electric power grid.

The bill may also increase the sequestration of carbon dioxide that would otherwise be emitted into the atmosphere through Class VI injection wells by authorizing the Department of Natural Resources to regulate these wells.

[1] Pursuant to Section 2-2-322.2, C.R.S., this greenhouse gas emissions report uses available data to assess whether a legislative measure is likely to directly cause a net increase or decrease in greenhouse gas pollution within the ten-year period following its enactment, The report will identify new sources of greenhouse gas emissions, any increase or decrease in emissions from existing sources, and any impact on sequestration of emissions. The report is authorized but not required to quantify the magnitude of the impact on the emissions, to the extent that unbiased estimates are feasible given the available data.

[2] Nonattainment areas refer to areas of the state that are not in attainment of National Ambient Air Quality Standards for criteria air pollutants as established by the U.S. Environmental Protection Agency.

Background

Gas-powered lawn and garden equipment. Gasoline-powered lawn and garden equipment, including lawnmowers, leaf blowers, trimmers, chain saws, chippers, and snow blowers are known sources of emissions including criteria pollutants, hazardous air pollutants, and carbon dioxide, which have been linked to adverse health effects. In addition to emissions resulting from fuel combustion, emissions also arise from gasoline spills during refueling, which then evaporate into volatile organic compounds, a precursor to ozone formation. This GHG emissions report assesses the impacts of lawn and garden equipment on carbon dioxide emissions only. The U.S. Environmental Protection Agency (EPA) estimated that approximately 136 million pieces of gas-powered lawn and garden equipment were in use nationally as of 2018, which were estimated to have emitted 22.8 million tons of carbon dioxide (CO_2), or 0.3 percent of total CO_2 emissions nationwide, for that year.[3] Although state-level GHG emissions data is not available, it is estimated that small non-highway mobile engines, which include lawn and garden equipment, emitted approximately 0.11 million metric tons of carbon dioxide equivalent in 2018, the most recent year available, accounting for around 0.1 percent of statewide emissions.

Class VI Geologic Sequestration Wells. Class VI wells are used for the geologic sequestration and long-term storage of carbon dioxide in deep rock formations. Sometimes referred to as carbon capture and storage, carbon dioxide is captured from industrial (e.g., steel or cement production) or energy-related sources (e.g., power plants or natural gas processing facilities) and injected into deep subsurface rock formations. Class VI injection permits are designed to protect underground drinking water sources and are regulated by the EPA in states, including Colorado, that have not enacted their own regulatory process for these permits.

Key Provisions and Assumptions

The bill includes a number of provisions that are expected to reduce greenhouse gas emissions in Colorado over a 10-year period and beyond. These provisions, and related data and assumptions, are discussed below.

Income Tax Credit

The bill creates an income tax credit equal to 30 percent of expenses in purchasing new, electric-powered, small off-road equipment for tax years 2023 through 2030. Small off-road equipment is defined as a lawn mower, leaf blower, or other lawn or garden equipment or any other off-road equipment as determined by the Air Quality Control Commission (AQCC) by rule. This emissions assessment is based on available information for push and riding lawnmowers. Information on the emissions savings for other lawn and garden equipment such as trimmers, leaf blowers, wood splitters, and chippers was not available.

[3] National Emissions from Lawn and Garden Equipment. U.S. EPA 2015. Available at: https://www.epa.gov/sites/default/files/2015-09/documents/banks.pdf

Sales of electric lawn and garden equipment. Table 1 below provides estimated sales projections for select lawn and garden equipment in Colorado. As Colorado sales data is not available, this report uses published California sales, adjusted for Colorado's population, and assumes a 1.7 percent annual growth rate. The fiscal note for SB 22-138 assumed that taxpayers will claim the tax credit for about 30 percent of electric lawn and garden equipment purchases each year, totaling 67,635 pieces of equipment in 2023, reaching 74,834 pieces in 2029.

Table 1
Projected Colorado Electric Lawn and Garden Equipment Sales

	2023	2024	2025	2026	2027	2028	2029
Lawnmower	16,063	16,336	16,614	16,896	17,184	17,476	17,773
Leaf blower	81,192	82,572	83,976	85,404	86,855	88,332	89,834
Chainsaw	21,028	21,386	21,749	22,119	22,495	22,877	23,266
Wood splitters	292	297	302	307	312	318	323
Tillers	120	122	124	126	128	130	132
Snow blowers	92	94	95	97	98	100	102
Riding mower	292	297	302	307	312	318	323
Chippers	63	64	65	66	67	68	69
Trimmers	106,309	108,116	109,954	111,823	113,724	115,658	117,624
Total	**225,451**	**229,283**	**233,181**	**237,145**	**241,177**	**245,277**	**249,446**
Credits Claimed	**67,635**	**68,785**	**69,954**	**71,144**	**72,353**	**73,583**	**74,834**

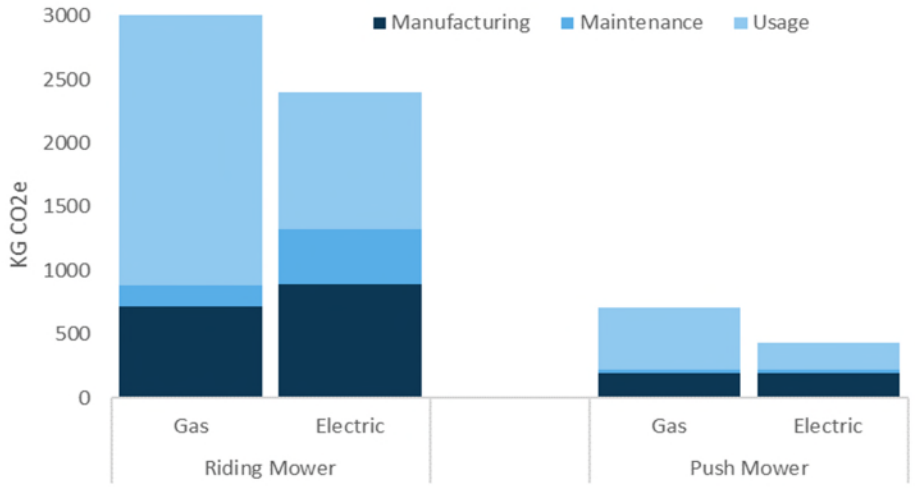
Source: Calculated by Legislative Council Staff using data on California 2018 new sales of electric lawn and garden equipment, adjusted for Colorado population and projected sales growth.[4]

GHG emissions savings. Replacing gas-powered lawn and garden equipment with electric-powered equipment reduces GHG emissions over the lifetime of the equipment. Combusting one gallon of gasoline produces around 19.5 pounds of carbon dioxide.[5] The GHG emissions savings from electric-powered equipment are accounted for by replacing the combustion of gasoline during the equipment's use with the consumption of electricity, which can be generated from a mix of energy sources, including renewable sources such as wind and solar power. Emissions savings depend on the resource mix used to generate electricity. As the percent of electricity generated by renewable sources increases relative to fossil-based sources, emissions savings increase. Partially offsetting these emissions savings, however, is an increase in emissions from the manufacturing and maintenance of electric-powered equipment. This is largely due to the increased energy needs to manufacture and replace the batteries.

[4] California sales data available at: https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020_Technical_Documentation_2020_09_09_Final_Cleaned_ADA.pdf.
[5] U.S. EPA. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

GHG emissions savings of lawnmowers. One life-cycle assessment study calculated the GHG emissions savings over a 10-year period for electric riding and push lawn mowers compared to gas-powered mowers in residential markets.[6] Nationally, electric push mowers are estimated to reduce GHG emissions by nearly one-half, and electric riding mowers by nearly one-third, compared to their gas counterparts. Taking into account Colorado's electric resource mix and associated emissions factors with electricity generation (i.e., pounds of carbon dioxide per megawatt-hour of electricity generated), emissions savings from electric equipment amount to around 40 percent for a push mower and 20 percent for a riding mower.

Figure 1
GHG Emissions Savings of One Residential Lawnmower
Over a 10-Year Lifecycle



Source: Adapted from Saidani, M. and Harrison, K., 2021.[7] Emissions from usage reflects Colorado's emission factor based on the electricity resource mix as of 2019.

Based on these results, for each residential gas-powered riding mower replaced by an electric-powered riding mower, around 0.6 metric tons of carbon dioxide will be saved over a 10-year time period, or 0.06 metric tons of carbon dioxide annually. Each electric-powered push mower will save around 0.3 metric tons of carbon dioxide over a 10-year period, or 0.03 metric tons of carbon dioxide annually, compared to its gas-powered counterpart.

Other lawn and garden equipment. While life cycle analyses on other lawn and garden equipment were not found, this report assumes that electric equipment such as leaf blowers, trimmers, and snow blowers will realize similar GHG emissions savings relative to their gas-powered counterparts; emissions from operation will decrease and be partially offset by increased emissions associated with manufacturing and maintenance, driven largely by the battery.

[6] Saidani, M. and Harrison, K. 2021. "Quantification of the environmental and economic benefits of the electrification of lawn mowers on the US residential market." The International Journal of Life Cycle Assessment. https://link.springer.com/article/10.1007/s11367-021-01917-x. The study assumed an average residential plot size of 0.25 acres for push mowers and up to 2 acres for riding mowers, and mowing times for a 26-week mowing season of 1 hour per week for a push mower and 1.5 hours per week for a riding mower. The study also assumed that the battery will be replaced after 5 years or 1000 charge cycles.
[7] Available at: https://link.springer.com/article/10.1007/s11367-021-01917-x.

Commercial Rebate Program

The bill requires the Department of Public Health and Environment (CDPHE) to establish a commercial rebate program for commercial lawn and garden care centers to earn a rebate for voluntarily replacing gas powered lawn and garden equipment with electric-powered equipment before January 1, 2030.

The emissions savings calculated in the previous section assumed average residential use activity, and did not account for the increased use of lawn and garden equipment for commercial lawn and garden care centers. Considering that more fuel will be displaced by electricity in commercial applications, greater emissions savings will be realized than in the residential sector. Assuming that riding and push mowers are used on average 400 hours per mowing season, the emissions savings from commercial lawnmower use will increase more than 10-fold compared to residential use.[8] Accounting for the increased use activity in the commercial sector, the estimated GHG emissions savings over a 10-year time period is calculated at 10.11 metric tons of carbon dioxide, or 1.01 metric tons of carbon dioxide annually, for each electric-power riding mower and 2.83 metric tons of carbon dioxide over a 10-year period, or 0.28 metric tons of carbon dioxide annually, for each push mower, holding manufacturing and maintenance emissions constant. If equipment, including batteries, used in the commercial lawn and garden center must be replaced more frequency than in residential settings, these emissions savings will be lower.

Nonattainment Area Prohibition

The AQCC is also directed to promulgate rules prohibiting the sale of gas-powered small off-road equipment in nonattainment areas after January 1, 2030. As of 2022, the Denver Metro/Northern Front Range, including Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and parts of Larimer and Weld counties are designed by the EPA as nonattainment for national ozone standards. The population in the nonattainment area currently accounts for over two-thirds of Colorado's total population of 5.8 million residents.

Class VI Injection Wells

The bill authorizes the Department of Natural Resources (DNR) to regulate Class VI injection wells by obtaining authority from the EPA to permit these wells. According to the EPA, only two wells are actively sequestering carbon dioxide, both located in Illinois. One well is permitted to inject 0.3 million metric tons of carbon dioxide per year with a maximum total injection volume of 1.0 million metric tons of carbon dioxide, and the other well is permitted to inject up to 1.2 million metric tons of carbon dioxide per year with a maximum injection volume of 6.0 million metric tons of carbon dioxide. In addition, there are nine pending pre-construction permits in other states.

Although there are no Class VI injection wells in Colorado currently, DNR has received expressions of interest from operators in developing well projects in Colorado. North Dakota and Wyoming recently obtained primacy for regulating Class VI injection wells and are actively processing permit applications. By transferring regulatory authority from the federal government to state government, this bill may spur activity in Colorado.

[8] The US EPA estimates the average annual hours of residential lawn mower use is 25 and the average annual hours for commercial lawn mowers is 406. Available at: https://www.epa.gov/sites/default/files/2015-09/documents/banks.pdf

Emissions Assessment

Beginning in tax year 2023, SB 22-138 is expected to reduce GHG emissions from the increased conversion of gas-powered lawn and garden equipment to electric-powered equipment. GHG sequestration activity may also increase once Colorado has obtained regulatory authority from the EPA over Class VI injection wells. These potential emissions savings are discussed below. This report provides emissions reduction estimates for electric lawnmowers based on available lifecycle data and assumptions. Emissions savings from other lawn and garden equipment are discussed qualitatively due to data limitations.

Income tax credit. To the extent that the income tax credit results in the replacement of gas-powered lawn and garden equipment with electric-powered lawn and garden equipment that would not have occurred without a tax credit, GHG emissions in Colorado will be reduced. The fiscal note for SB 22-138 estimates that 30 percent of customers purchasing equipment will claim the income tax credit. However, some portion of consumers claiming the credit would have switched from gas powered equipment to electric equipment regardless of whether or not the credit was available, and exact data is not available to indicate what percent of purchases of electric equipment were driven solely or primarily by the availability of the tax credit. Findings from past reviews of tax credits for energy-efficiency investments provide unclear evidence of the induced demand spurred from these incentives.[9] One study suggests that federal renewable energy tax credits have spurred 23 percent more growth in renewable energy capacity than would have occurred without tax credits.[10]

For informational purposes, this report estimates the GHG emissions savings for electric lawnmower purchases based on an assumption that 10 percent of individuals claiming the tax credit, from the total pool of persons claiming the credit, which is estimated at 30 percent of total sales, were incentivized to purchase the electric equipment due to the tax credit. The table below provides the annual GHG emissions savings for these customers, assuming residential use activity. These emissions savings are calculated based on the results of the life-cycle assessment study referenced above.

[9] For example, a recent analysis by the Congressional Research Service on Residential Energy Tax Credits concluded that the amount of additional investment resulting from residential energy-efficiency tax credits is unclear, as purchasers are motivated by other factors such as concern for the environment.
[10] Natural Resource Defense Council. 2017. Available at: https://www.nrdc.org/experts/kevin-steinberger/renewable-energy-tax-credits-will-power-economic-growth.

Table 2
Estimated Annual GHG Emissions Savings from Income Tax Credit
(Metric tons of Carbon Dioxide Equivalent)

	Push Mowers		Riding Mowers		
Year	Number In Use	Emissions Reduction	Number In Use	Emissions Reduction	Total Reduction
2023	482	13.35	9	0.55	13.90
2024	972	26.92	18	1.10	28.02
2025	1,470	40.72	27	1.66	42.38
2026	1,977	54.76	36	2.21	56.97
2027	2,493	69.06	45	2.76	71.82
2028	3,017	83.57	55	3.37	86.94
2029	3,550	98.34	65	3.98	102.32
2030	3,550	98.34	65	3.98	102.32
2031	3,550	98.34	65	3.98	102.32
2032	3,550	98.34	65	3.98	102.32
10-Year Total	**3,550**	**681.72**	**65**	**27.57**	**709.31**

Source: LSC calculations, based on life cycle assessment.

Note: These emissions savings are based on residential use activity and hold the emissions intensity of electricity generation constant at 2019 rates (1,242 pounds of CO2e/MWh)

Based on these sales assumptions, the income tax credit is expected to reduce GHG emissions by around 13.9 metric tons of carbon dioxide in 2023, accumulating to around 102.3 metric tons of carbon dioxide by 2029 as more electric lawnmowers are displacing their gas-powered counterparts. After tax year 2029 when the credit expires, annual GHG emissions savings attributable to this bill will plateau at 2029 levels, unless electric equipment is replaced with gas equipment at the end of the equipment's expected lifetime of 10-years.

Commercial rebate program. Although the bill does not specify a scale of the commercial rebate program, based on life cycle assessment results and adjusted to account for commercial use activity, the estimated emissions savings can be calculated for a hypothetical rebate program. Assuming an average cost of $570 and $3,500 for push and riding mowers respectively, and a rebate program to cover one-half of these costs, annual program expenditures of $100,000 could fund 175 push mowers and 29 riding mowers annually if funds are divided evenly. Assuming these electric mowers replace gas-powered mowers that would not otherwise have been replaced, the table below reflects the annual emissions savings associated with a rebate program that runs from 2023 through 2031.

Table 3
Estimated Annual GHG Emissions Savings from Commercial Rebate Program
(Metric tons of Carbon Dioxide Equivalent)

	Push Mowers		Riding Mowers		
Year	Number In Use	Emissions Reduction	Number In Use	Emissions Reduction	Total Reduction
2023	175	49.58	29	29.31	78.89
2024	350	99.16	58	58.63	157.78
2025	525	148.73	87	87.94	236.67
2026	700	198.31	116	117.25	315.56
2027	875	247.89	145	146.57	394.45
2028	1050	297.47	174	175.88	473.34
2029	1225	347.04	203	205.19	552.23
2030	1400	396.62	232	234.51	631.13
2031	1575	446.20	261	263.82	710.02
2032	1575	446.20	261	263.82	710.02
Total	**1575**	**2,677.19**	**261**	**1582.91**	**4260.10**

Source: LCS Calculations, based on life cycle assessment results and adjusted for commercial activity.

Note: These emissions savings hold the emissions intensity of electricity generation constant at 2019 rates (1,242 pounds of CO2e/MWh)

Under this hypothetical rebate program, GHG emissions savings from equipment purchased through the rebate program are estimated to be around 78.9 metric tons of carbon dioxide in 2023, accumulating to 710.0 metric tons of carbon dioxide by 2031. The commercial rebate program is scheduled to repeal on January 1, 2032, and future savings are assumed to continue at 2031 levels for the remainder of the equipment's life cycle. Actual emission reductions will vary depending on the exact amount of funding provided and the amount of equipment that can be purchased or subsidized within available appropriations.

Future projections of emissions associated with electricity generation. The emissions savings calculated above holds emissions intensity (i.e., pounds of carbon dioxide per megawatt-hour of electricity generated) constant based on the electricity resource mix as of 2019, the most recent year available from the EPA.[11] In 2019, the EPA calculated the emissions intensity of Colorado's statewide electricity generation to be 1,242.6 pounds of carbon dioxide for every megawatt-hour of electricity generated, based on a fuel mix of natural gas (26.5 percent), coal (42.5 percent), hydro (11.9 percent), wind (16.9 percent), and solar (1.8 percent).

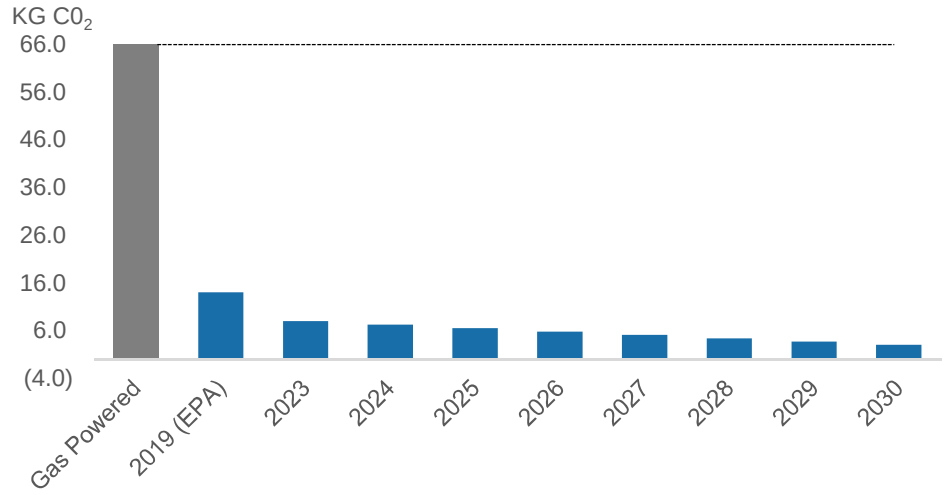
As a result of legislation and electric utility commitments to meet clean energy targets, the emissions intensity of electricity generation is projected to decrease in future years as fossil fuels are replaced with renewable resources such as wind and solar energy. Although final projections are not available, the Colorado GHG Pollution Reduction Roadmap[12] estimates that, based on clean energy plans and coal plant retirement plans, GHG emissions from the electricity sector will be reduced by 32.3 million metric tons of CO_2 by 2030, reaching a targeted emissions level of 8 million metric tons of CO_2 by 2030. If these emissions savings are realized, the emissions intensity of electricity generation in Colorado

[11] U.S. EPA Power Profiler. Available at: https://www.epa.gov/egrid/power-profiler#/RMPA.
[12] CO GHG Pollution Reduction Roadmap. Available at: https://energyoffice.colorado.gov/climate-energy/ghg-pollution-reduction-roadmap.

will reduce to around 275 pounds of CO_2 for every megawatt-hour of electricity generated by 2030. This will result in increased GHG emissions savings for electric-powered lawn and garden equipment in future years.

For illustrative purposes, the figure below shows how annual carbon emissions from the use of a push lawn mower change over time as the state's energy mix changes. Note that this reflects only the operating emissions, which is a portion of the entire life-cycle assessment discussed above. Emissions from one electric push lawnmower are projected to decline from around 8 kilograms of CO_2 to 4 kilograms of CO_2 between 2023 and 2030, based on 25 KWhs of usage per year.

Figure 2
GHG Emissions Projections for One Electric Push Mower – Annual Usage Only



Source: LCS calculations, based on 25 hours per year of use. Gas powered emissions assumes 0.3 gallons of gasoline per hour and is based on EPA emissions factor of 8.887 kg CO_2 per gallon of gasoline. Electric-powered push mower assumes 25 KWh per year of use. Emissions for 2019 are based on EPA emissions intensity rates (564 kg CO2/KWh of electricity). Emissions for 2023 through 2030 are based on projected emissions intensity rates as calculated using projected demand and GHG emissions savings from the CO GHG Pollution Reduction Roadmap.

Nonattainment area prohibition. It is not known how many pieces of gas-powered lawn and garden equipment will be replaced with electric-powered equipment as a result of a prohibition on the sale of gas-powered lawn and garden equipment in nonattainment areas beginning in 2030. Individuals may opt to not replace their existing equipment, or may purchase gas-powered equipment outside of the nonattainment area. Because of these unknowns, the emissions savings from the nonattainment area prohibition beginning in 2030 cannot be calculated.

Class VI Injection Wells. To the extent that transferring regulatory authority from the EPA to Colorado spurs interest and activity in the geological sequestration of carbon dioxide, emissions may reduce in the future. As discussed above, annual CO_2 injection rates for permitted wells may be up to 1.2 million metric tons per year, based on projects in other states. Potential emissions reductions in Colorado will be determined by industry interest and permitted activity once DNR begins regulating these wells.

Limitations. The 10-year emissions savings calculated in this analysis assume that without the income tax credit or commercial rebate program, consumers would continue to use gas-powered equipment over the same 10-year time period. Market and other factors may induce demand for electric-powered lawn and garden equipment in future years, such as declining prices. Thus, it is difficult to determine to what extent emissions savings are attributable to the incentives created by SB 22-138. In addition, due to data limitations, emissions impacts from other lawn and garden equipment are not quantified in this report, but may increase the emissions savings attributable to the bill.

Data Sources and Agencies Contacted

Public Health and Environment
U.S. Environmental Protection Agency